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Evaluation of Radionuclide Encapsulation on Spent HEPA Filters

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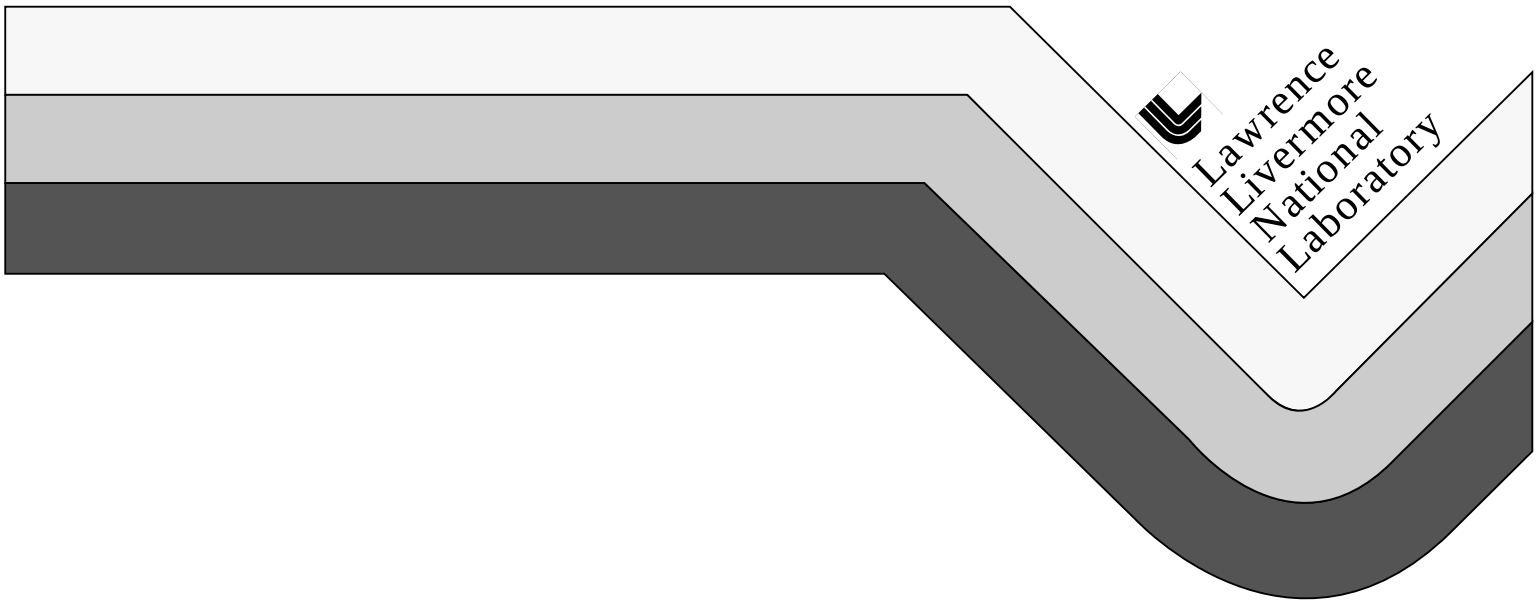

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Draft Scope of Work for Possible Collaboration with the Russian Scientific Community at Arzamas-16

Scope Of Work Title:

Evaluation of Radionuclide Encapsulation on Spent High Efficiency Particulate Air Filters

Purpose:

The purpose of this project is to determine the feasibility of fog dispersant encapsulation of spent HEPA filters.

Scope:

This project includes the following:

- The design and construction of a testing rig
- Use of HEPA filters that are functionally equivalent to those in MEL-352 J (Size V) in burning materials contaminated with radionuclides (such as wood burning at the Chernobyl site).
- Characterizing the filters for radioactive contamination
- Using the testing rig to fog encapsulate the HEPA filters
- Characterizing the encapsulated HEPA filters

Background and Justification:

Many questions have been raised about the actual efficiency of HEPA filtration systems. The standard specification for these filtration systems is 99.97 percent removal of particulate of 0.3 microns are greater (nominal diameter). This particular specification is difficult to measure in practice and for most systems this level of efficiency may be too high or too low for a given system. This specification is practically impossible to verify with field instruments during operation. What is usually done is to place test ports in the HEPA influent and effluent duct lines usually 4 to 6 duct diameters away for influent straight runs and 7 to 10 duct diameters away for effluent straight runs to reduce turbulence. Then within the influent test port, a smoke tube is placed. This tube elutes a mist of dioctyl phthalate (DOP). During this elution, effluent air is drawn from the test port down stream. If the air down stream appears to show a color change in the sampled air (calorimetric change of DOP with indicator) the HEPA is “failed” and must be replaced.

The HEPA filters are buried in landfills, in whole, with no regards to possible contamination leaks do to "dust" falling out of the HEPA filters. HEPA filter plenums are usually covered with can lids and taped or they are bagged in a thick polyethylene bag. The influent side may have contamination that will "fall out" because the impingement force was not great enough to bury the particulate sufficiently into the HEPA fabric. Adsorption forces change with HEPA surface charge and temperature. These forces may also not be great enough to retain small HEPA particulate. This packaging method may be reduced or eliminated and wastes can be minimized by encapsulating the HEPA fabric.

HEPA filter fabric is less than 5% of the total volume of a HEPA filter. The filter is composed of reinforcement material, plenum duct connections, spacers and surface area enhancers, construction support, and nailed together plywood housing. This material may be safely size reduced, recycled, and or decontaminated if dismantlement is possible. Dismantlement is not practical due to loose contamination on the HEPA fabric. Dismantlement is only possible if public safety can be enforced. An ideal method to enforce this safety is to encapsulated the HEPA fabric and interior contamination.

Objectives:

The major objectives are given below:

- To evaluate the possibility of encapsulating HEPA filters by using a nozzle generated fog of plastic (monomer injected with catalyst, activator or copolymer).
- To ready commercialization of an encapsulator by fabrication of a test rig
- To evaluate size reduction potential, and to characterize HEPA filters before and after processing through the test rig.

Work to be Performed:

Stage 1: Performing Site Investigation and Planning the Project

The first stage of the work will be to provide options of sites for investigation. This will include a report that contains but is not limited to the following information:

- An indication of HEPA filter types, sizes and quantities used
  - CFM rating, particle size removal efficiency
  - Internal and external dimensions
  - Testing used to validate the HEPA filter use
  - Quantity available for examination before and after test rig encapsulation
  - Blue prints and manufacturer's name and contact information
- Processes which were performed that contaminated the filters
  - Complete narrative description
  - Describe all monitoring available
  - Pressure drops, CFM of process stream
  - General description of off-gas
  - pressure drop versus time operating over the life of the HEPA filter
- Site characteristics
  - humidity, temperature, and pressure history
  - radiation impacts on site
  - location of where HEPAs are generated
  - describe all receptors
  - describe elevation of site and site soil and wind characteristics
  - describe where and how the test rig will be set up
- Perform the planning
  - Prepare a work breakdown structure
  - Prepare an activity schedule
  - Prepare a description of resources to be used
  - Prepare an itemized cost of each activity and each work breakdown structure
  - Prepare a list of contacts and pathways for which they may be reached

Stage 2: Design and construction of a HEPA Filter Testing Rig

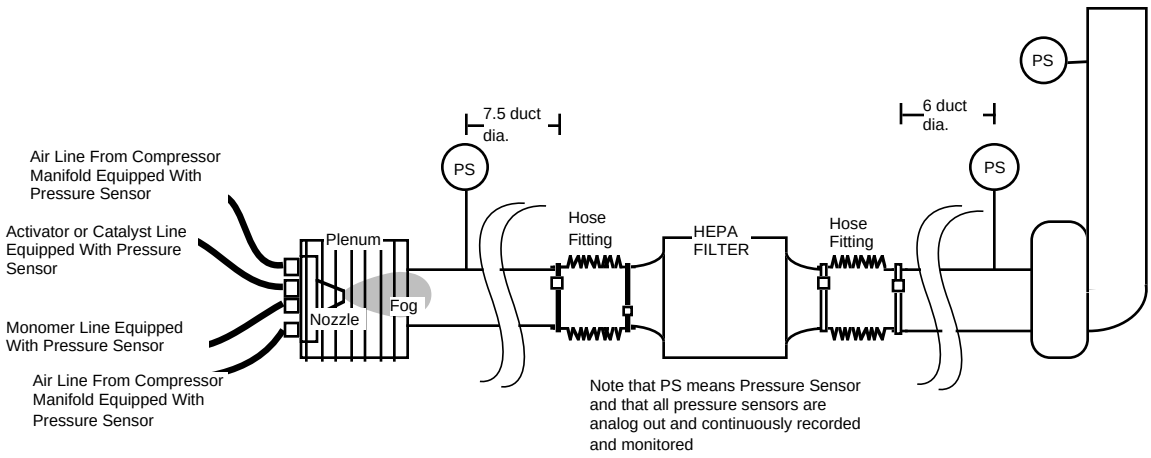
The second stage is to design and report the design of a HEPA encapsulation test rig.

- Complete preliminary design
- Incorporate comments from design review
- Complete final design

Both the final design and preliminary design must include the following information:
- Supply description of how the test rig is to be used
- Described how the nozzle or nozzle array will be used
- Provide data or cut sheets on all sub components

A conceptual schematic of the rig appears below in figure 1.

Figure 1. Conceptual Design of HEPA filter Test Rig.



Stage 3: Characterization of HEPA filters and Evaluation of Encapsulation:

HEPA filters will be categorized and grouped. Each group will be based on process type and location. All HEPA filters that were used and now are considered "spent" or are discarded as waste will be categorized by process type and location (e.g., incinerator near Chernobyl burning radioactive waste from Chernobyl). Each group will have a sub category based on the pressure drop across the spent filter (e.g., less than 4" of water and greater than or equal to 6" of water). At least 4 HEPA filters from each sub category must be available. Each filter will be characterized. Half of the filters will be characterized (from each sub category) before encapsulation and after encapsulation.

Characterization of the HEPA filters prior to encapsulation will be performed as follows:

Filters will be inverted onto a clean, flat, and smooth surface. The inlet side will be placed down upon the surface. The filter will then be dropped from a height of 20 centimeters 5 times onto the surface. The weight of the residue upon the flat surface shall be recorded and a sample of this residue will be taken and analyzed by gamma and alpha spectroscopy. The sensitivity of these measurements shall be no greater than 0.03 disintegrations per second. Each filter shall be disassembled. The fabric shall be placed gently on a flat surface with the outlet side down against the flat surface. Color photographs shall be taken (a minimum of 3 each filter fabric) to clearly show the residue pattern on the filter. Swipes and Samples of this filter will be counted by liquid scintillation to determine the radioactive density of the filter fabric for both fixed and loose contamination. This must be graphically represented. A sample must be counted at a frequency of at least 1 sample per 100 square centimeters with a sensitivity of .01 disintegrations per second for each sample.

Characterization of the HEPA filters after encapsulation will be performed as follows:

The same protocols will be followed in characterization of spent HEPA filters before the encapsulation. Before the spent filters are characterized, optimum spray patterns, monomer and activator (copolymer, or catalyst addition) rates, and compressed air feed rate will be determined. A nozzle will be selected that provides for the finest practical droplet size at a suggested optimum pressure. Unused filters will be loaded into the test rig (one at a time per run). The nozzle will be set to operate at the suggested pressure. The air flow will be reduced from a maximum to a practical minimum and feed plastic materials will start off at zero feed and be increased to the maximum practical pressure (while reducing the air pressure to maintain a constant total pressure). This will be done in stages. At least 4 runs will be used to perform this task. At the end of each run, when pressure equals or exceeds 6" of water, the filter will be dismantled and the filter fabric will be laid out (outlet side down) and examined for spray coverage. Color photographs shall be taken (a minimum of 2 each filter fabric) to clearly show the plastic pattern on the filter and to determine coverage. Once it has been decided that coverage has been optimized, proceed in testing the spent filters using the test rig.

Reporting (deliverables)

All documentation shall be written in both Russian and English. All figures, drawings, blue-prints, and tables shall be annotated, titled, and labeled in Russian and English. All documents shall be legible and presented in such a way as to last under normal use for a minimum of 5 years. Each document shall be supplied with 2 copies (3 in total).

The following documents are deliverables:

Deliverable 1: Project Plan

A project plan will be required. This plan will include a work break down structure, a schedule including deadlines and deliverable completion times. A cost estimate by schedule and by work breakdown structure of each element and task must be given. A resource allocation description including the number and type people on a task and in a work break down element. The description should include the area of discipline. The project manager's name and contact avenue and the all work breakdown structure element leader's names and contact avenues shall also be supplied. The total project duration shall not exceed 1 year.

Deliverable 2: Spent HEPA Source, type, and Site Characteristics

Investigation of HEPA filter source, quantity, and location (Stage 1) must be given. This will consist of a report in narrative format in English. The report will include tabulated data summarizing what is requested in the work section of this document first stage.

Deliverable 3: Preliminary Design

A preliminary design of a HEPA filter rig, with minimum elements as discussed in the work section of this document must be performed and documented. This rig design will be commented on by the LLNL project leader. All comments need to be addressed and changes need to be agreed upon prior to putting together a final design package.

Deliverable 4: Final Design

A final design will have the same elements as the preliminary design but will include comments and a discussion of agreed upon changes. Approval of construction must be given by the LLNL project leader prior to procurement of subcomponents and construction of the rig.

Deliverable 5: Construction Report and As Builts

Construction of the rig will be followed by, color photographs of the rig (Back, Front, Top, Left and Right sides, one photo each), as built drawings, all manufacturer cut sheets, and a complete design package.

Deliverable(s) 6 : Test Report(s)

Test and characterization reports will include duration of tests, location of tests. All elements discussed in the work section of this document should be included in these test and characterization reports. One report shall be done for every HEPA filter characterized (including the one characterized before and after the tests).

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